

SECTION 2 HANFORD SITE HISTORICAL OVERVIEW

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2.0 Hanford Site Historical Overview

2.1 Site Description

The Hanford site was established by the Manhattan Project as the plutonium production site for the U. S. World War II defense effort. The site initially consisted of ~1,735 square kilometers (~670 square miles) of primarily remote, semiarid land. Over time, this has been reduced to ~1,450 square kilometers (~560 square miles) as parcels of land no longer needed by the site were made available for other uses. The site has access to significant water and power supplies and nearby barge shipping, road, air, and rail facilities. Construction was initiated in March 1943 to build facilities to produce plutonium for the first atomic bombs. The principal early facilities included B-, D-, and F-Reactors, the 313 Fuel Fabrication Facility, the T-Plant and B-Plant fuel processing facilities for plutonium separation, and the 231 Isolation Process facility for final plutonium purification and concentration. Waste storage tanks, laboratory facilities, warehousing, roads, power plants, housing, and a myriad of other support facilities were simultaneously built during the construction period. Initial plutonium production commenced in September 1944 when the first reactor was brought on line. The first batch of refined plutonium was available for the war effort in February 1945.

Buildup of the Hanford site continued for many years in support of nuclear weapons program needs. Additional facilities were eventually needed to satisfy planned plutonium production requirements and to improve process efficiencies. An additional six reactors and four processing facilities were constructed and operated, including: the Reduction Oxidation (REDOX) Plant, U-Plant, UO_3 Plant, and the Plutonium-Uranium Extraction (PUREX) Plant. During the plutonium production years at Hanford, uranium was received at the site, fabricated into nuclear fuel, irradiated for plutonium production, and processed to recover the plutonium. Until about 1952, the waste from plutonium separation, which included fission products and unused uranium, was stored in large, underground waste tanks. After 1952, uranium was mined from these tanks and recovered for reuse. All subsequent fuel processing operations included uranium recovery and recycle. Most of this uranium was shipped offsite for recycle and contained residual trace quantities of transuranics and fission products. By 1994, all plutonium production and uranium recovery activities were shutdown and a cleanup mission for the Hanford site was initiated. A brief historical timeline of Hanford's history is provided in Appendix H.

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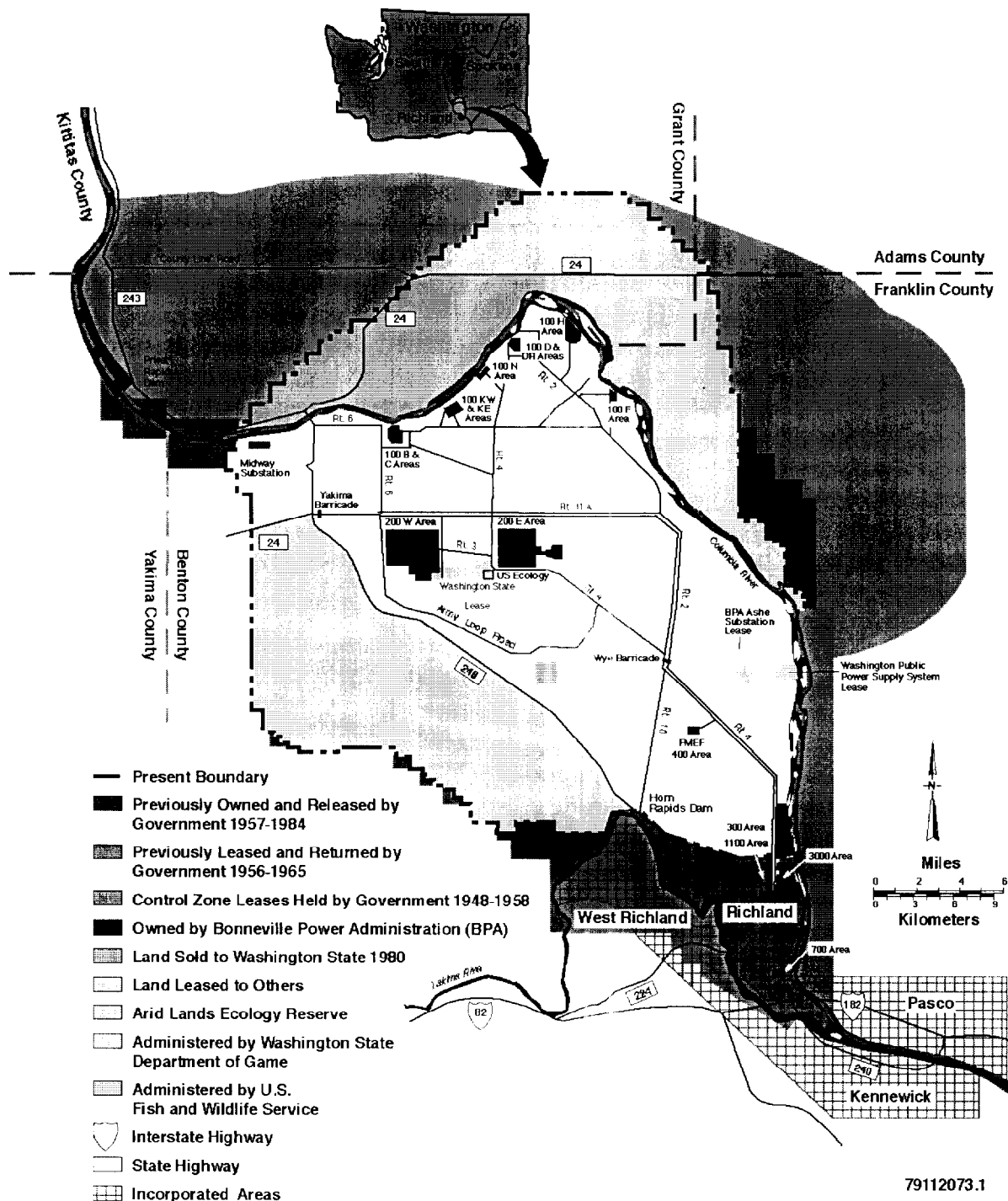


Figure 2-1 The Hanford Site, Richland Washington

Figure 2-1 shows a map of the Hanford Site. Fuel fabrication facilities were located in the 300 Area (South corner of the site). General fabrication, administrative, and other

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support functions were located nearby in facilities in the 700, 1100, and 3000 Areas. Completed fuel was shipped to the reactors at the 100 Areas (B, C, D, DR, F, H, KE, KW, and N) located along the south shore of the Columbia River in the northern portion of the Site for use in the reactors. After irradiation, the fuel was stored in pools at the reactors for a cooling period and then transported in special rail cars to the separation processing facilities located in both the 200 W and 200 E Areas. Discarded high level waste from the separation plants were transferred to storage in underground storage tanks located in both the 200 W and 200 E Areas. All recovered solutions of uranium were transported to the UO_3 Plant located in the 200 W Area for conversion to oxide.

2.2 Key Uranium Processing Facilities

As part of the Manhattan Project and its successors, the U. S. Atomic Energy Commission (AEC), Energy Research and Development Administration (ERDA), and the U. S. Department of Energy (DOE), a number of specialized facilities were constructed at the Hanford site and operated between 1943 and 1986 to produce fuel for the nine plutonium production reactors and to recover plutonium and uranium from the irradiated fuel. A historical overview of all the major plants, process flows, and facility interfaces at Hanford is shown in Figure 2-2. All of the uranium received at Hanford for non-research reactor operation was fabricated into fuel in the 300 Area throughout Hanford's production mission. This fuel was used in nine production reactors which operated over various time periods. Essentially all of the irradiated fuel went to one of four separation processing facilities; T-Plant, B-Plant, REDOX, and PUREX. In addition, the U-Plant was operated for a short time period to recover uranium from high level waste from the early T- and B-Plants, which did not have the capability to recover uranium during irradiated fuel processing. All of the high level waste from the processing of irradiated fuel was transferred to underground storage tanks. Recovered plutonium was refined and converted to a suitable chemical form in either the 231-Z Isolation Building or the Plutonium Finishing Plant. Recovered uranium (as recycle uranium) was converted to a stable oxide for shipment in the UO_3 Plant. The remainder of this section provides a brief description of the facilities, processes, and operating history for the major Hanford uranium processing plants.

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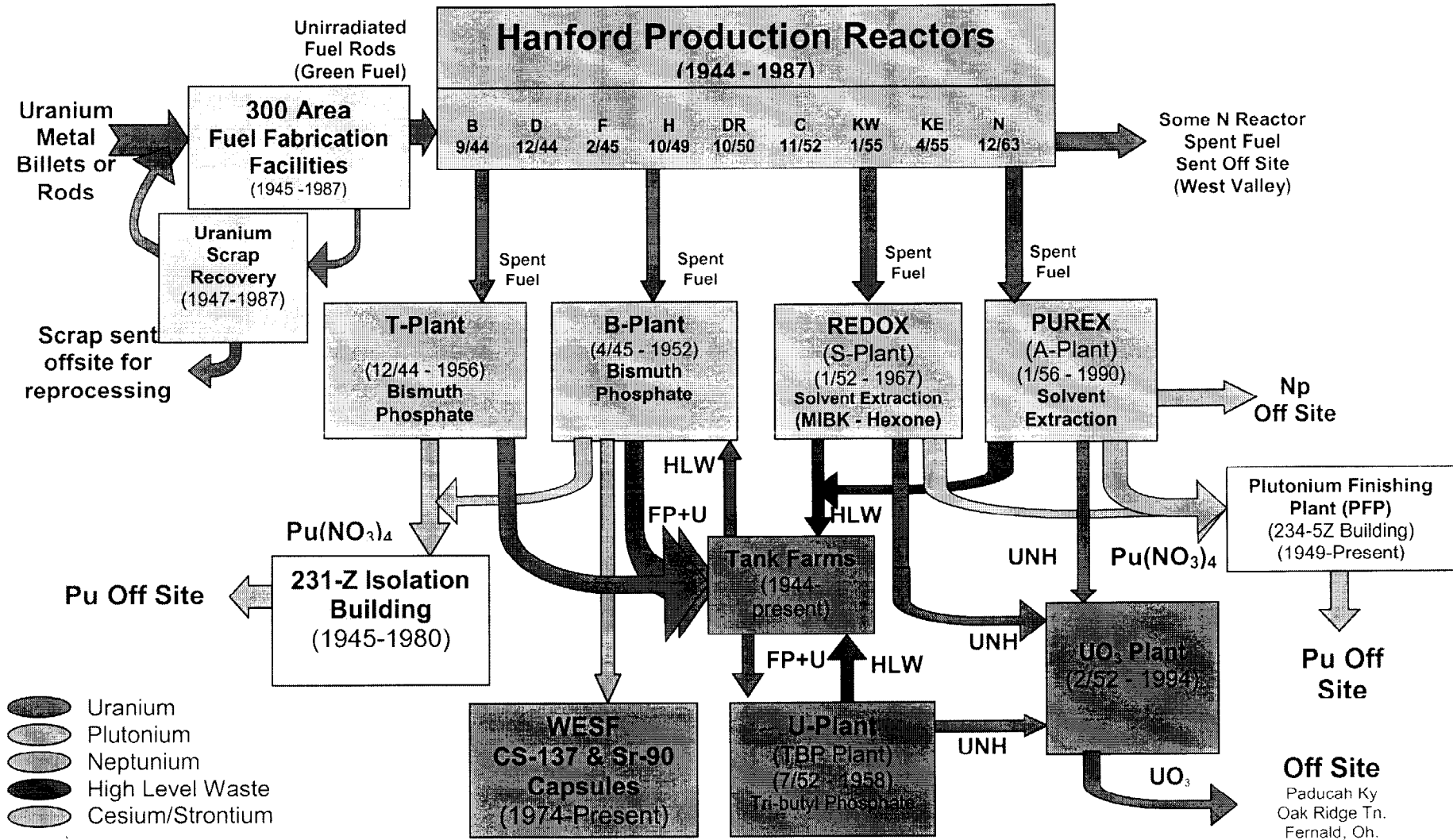
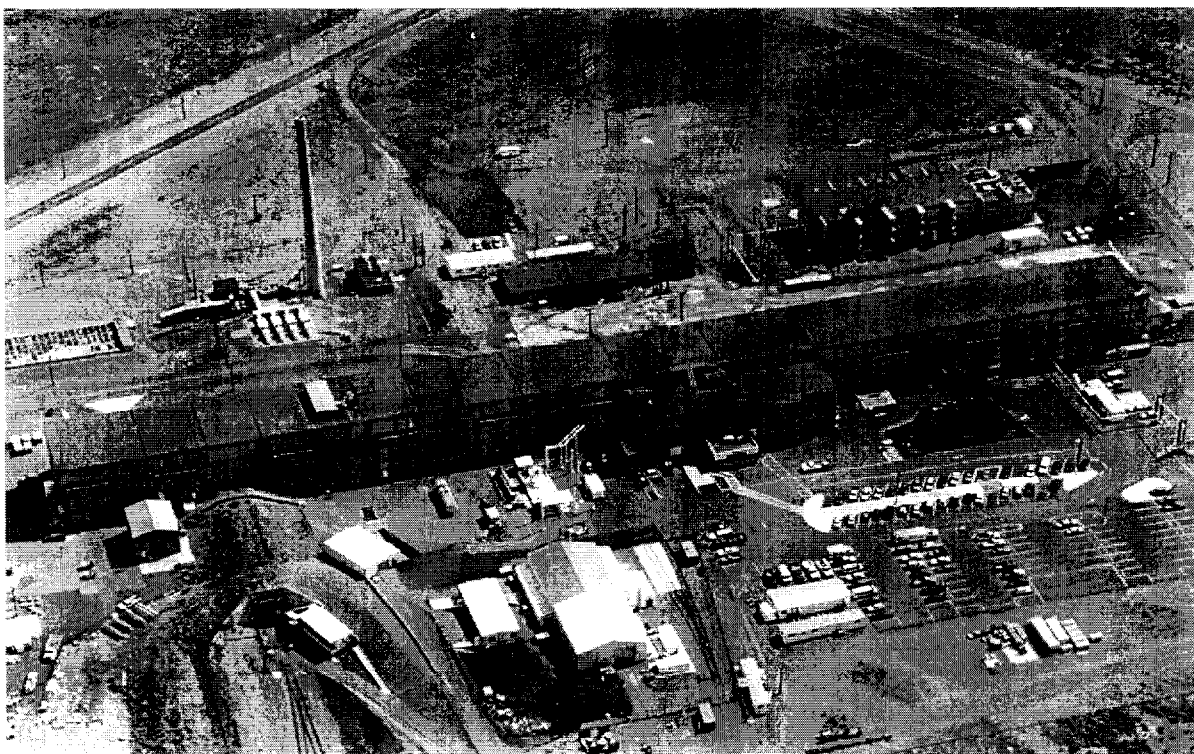


Figure 2-2 Hanford Major Process Flows and Facility Interfaces

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2.2.1 T-Plant

T-Plant was the first of three separations plants built at Hanford by the Manhattan Project.

2.2.1.1 Plant Description

T-Plant (the 221-T Cell Building), located in the 200 West Area of Hanford, is 85 feet wide by 875.5 feet long by 102 feet high. It is a reinforced concrete, windowless structure. Approximately 25% of the building is located below grade. The building enclosed a bismuth phosphate plutonium extraction process. The process equipment was located in 20 heavily shielded cells that provided needed radiation shielding for the personnel processing irradiated uranium fuel. The process involved dissolution of irradiated uranium fuel from the reactors and extraction of plutonium. Process equipment maintenance was accomplished remotely. Shielded transfer piping provided the path for liquid chemical transport between the cells [Gerber 1996].

2.2.1.2 T-Plant Material Flowsheet

The material flowsheet was developed early in the facility construction period. Initially the facility was expected to process about one ton of irradiated uranium per day. Over years of operation, changes to the processes and modification to the bismuth phosphate chemistry resulted in improved performance. A simplified process flow diagram for the bismuth phosphate separation process is depicted in Figure 2-3. This

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process was developed by Glenn T. Seaborg in the early 1940s and applied at Hanford to achieve separation of the plutonium produced from irradiated uranium. Uranium was not recovered, and both the fission products and uranium were sent to large underground waste storage tanks.

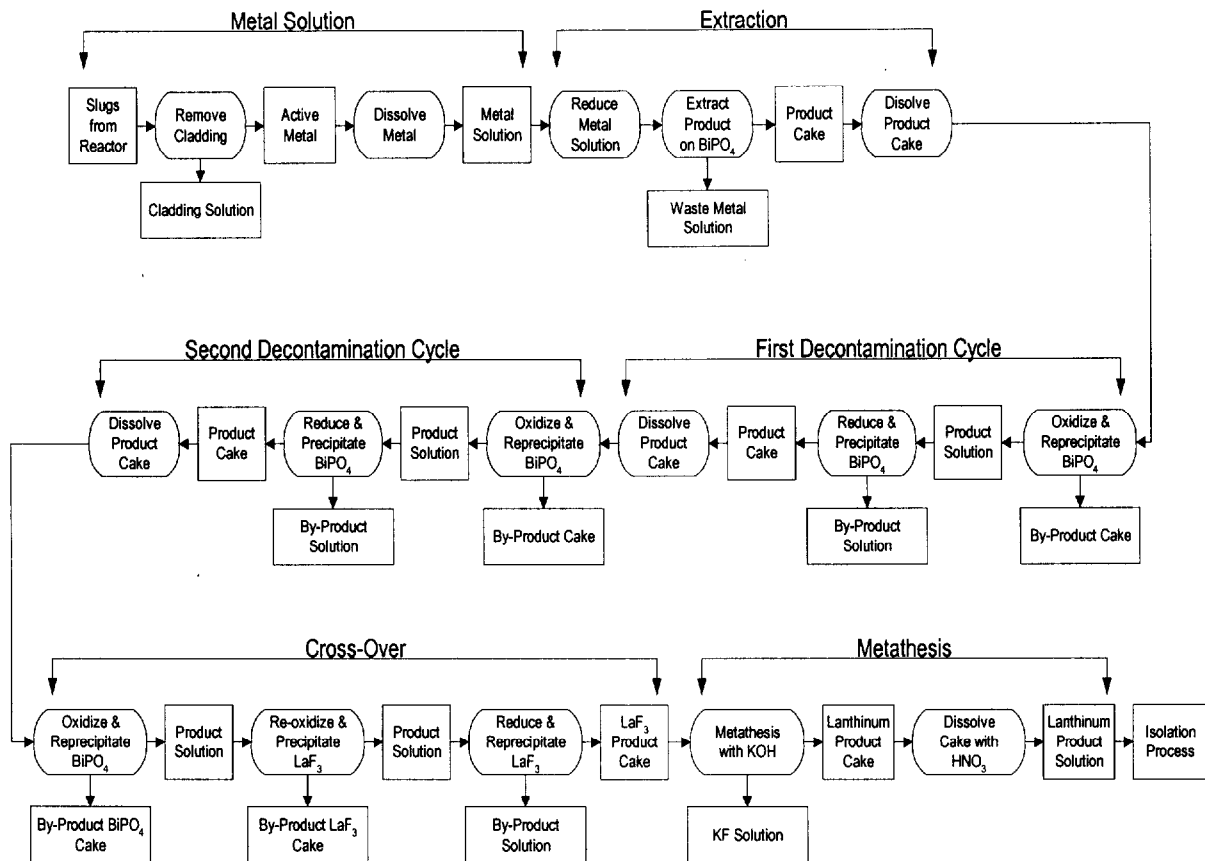


Figure 2-3 T-Plant Process Flow Diagram

The process consisted of removing the aluminum cladding from the irradiated fuel rods (also known as "slugs") in dissolver tanks using hot sodium hydroxide. The cladding waste was drained from the dissolver tanks and transferred to the underground waste tanks. The declad slugs were washed with water to remove any residual hydroxide. Nitric acid was then added to dissolve the bare uranium slugs and form a uranium nitrate solution. The uranium nitrate solution was chemically adjusted with sulfuric acid and sodium nitrite to assure extractability of the plutonium from the uranium solution. Bismuth nitrate and phosphoric acid were added to co-precipitate plutonium and bismuth as insoluble phosphates. The solution was centrifuged from the bismuth phosphate co-precipitate. Waste solutions containing uranium and fission products were treated and sent to the underground waste tanks. The solid cake was water washed and dissolved in concentrated nitric acid. The nitrate solution was chemically adjusted to permit precipitation of metal contaminants upon addition of bismuth nitrate while maintaining the plutonium in solution. The solution was again chemically treated and

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bismuth nitrate and phosphoric acid added to co-precipitate the plutonium, further reducing the metal contaminants. This precipitation, re-solution and re-precipitation process was repeated two more times to further reduce the metal contaminants and reduce volume. Final purification of the plutonium was accomplished by repeated co-precipitation using lanthanum nitrate and hydrofluoric acid to form the lanthanum fluoride which served as the carrier. Upon completion of the purification steps, the plutonium was dissolved in nitric acid and transferred to the Isolation Process Facility (231-Z building) for final treatment and concentration.

2.2.1.3 Feed Specifications

Feed for the extraction process was irradiated natural uranium and the expected plutonium content was low. During the 10 years of T-Plant operation, the irradiated fuel feedstock varied in plutonium and fission products content as the reactor operations were improved and power levels increased.

2.2.1.4 Product Specifications

Plutonium nitrate solution was the principal product of T-Plant and the nitrate solution was further purified at the 231-Z Facility. The uranium and fission products were discharged to the underground waste tanks. Waste transferred to the underground tanks was chemically adjusted to minimize corrosion of the tanks using specifications based on maintaining alkalinity and nitrate/nitrite concentrations. Since uranium did not play an important role in corrosion control, no purity requirements were established for the waste uranium [HW-10475-ABC 1944].

2.2.1.5 Operating History

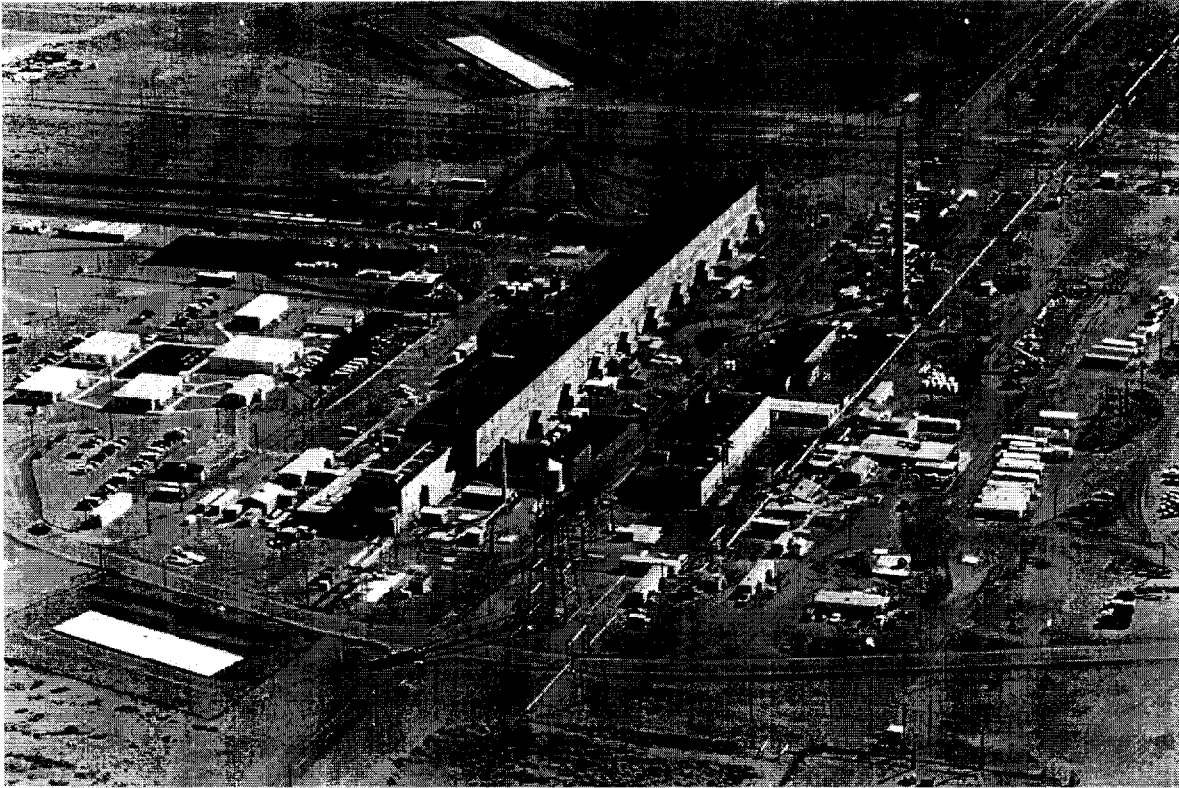
Processing of irradiated uranium fuel commenced on December 26, 1944, in the T-Plant. A number of operational improvements and installation of a third fuel dissolver in 1954 increased plutonium production rates. T-Plant was shut down in March 1956 following startup of the PUREX plant in January 1956.

2.2.1.6 Current Status

T-Plant is used on an irregular basis as an equipment decontamination and repair facility supporting Tank Farms operations. Although recently the 224-T Building was used for TRU waste storage, the TRU has now been removed and 224-T is now being deactivated.

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2.2.2 B Plant

B-Plant was second of the three separations plants initially built by the Manhattan Project.

2.2.2.1 Plant Description

B-Plant (the 221-B Cell Building) is located in the 200 East Area and was constructed in the same time frame as T-Plant. B-Plant started processing irradiated uranium fuel on April 13, 1945. Physically, B-Plant is nearly identical to T-Plant. It is 65 feet shorter in length than T-Plant because it did not include the two equipment development cells provided in T-Plant. Like T-Plant its mission was to recover plutonium from irradiated uranium fuel using the bismuth phosphate process. The process equipment was also located in heavily shielded process cells [Gerber 1996].

2.2.2.2 Material Flowsheet

B-Plant shared the same flowsheet as T-Plant. Process modifications to improve efficiency were similar to those made at T-Plant, but B-Plant did not operate as a plutonium separations plant for as long as T-Plant.

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2.2.2.3 Feed Specifications

The feed specifications for B-Plant were the same as those for T-Plant, described earlier.

2.2.2.4 Product Specifications

Like T-Plant, B-Plant's principal product was plutonium nitrate solution. The uranium and fission product wastes delivered to the underground tanks were chemically adjusted to assure adequate control of expected tank corrosion using specifications based on maintaining alkalinity and nitrate/nitrite concentrations [HW-10475-ABC 1944].

2.2.2.5 Operating History

B-Plant began processing irradiated uranium fuel in April 1945 using the bismuth phosphate process. Plutonium recovery continued until 1952 when the plant capacity became unnecessary once the combined output of T-Plant and REDOX was sufficient to satisfy production needs. In 1968, the plant was converted to a waste fractionation plant. Cesium and strontium were removed from the high level tank wastes and encapsulated [Gerber 1996].

2.2.2.6 Current Status

The cesium and strontium capsules are currently being stored in water filled basins in an addition on the west end of the plant. Present plans call for vitrification of these capsules as high level waste. The remainder of the plant has been shutdown.

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2.2.3 U-Plant

U-Plant was the third of the original three separation plants to be built by the Manhattan Project. This facility was also known as the TBP-Plant and the Metal Recovery Plant. It was initially used to train operators for B- and T-Plants. Later, it was modified to recover uranium in waste slurry “mined” from the high-level wastes in Hanford’s tanks.

2.2.3.1 Plant Description

U-Plant is located in the 200 West Area and is almost identical to T-Plant. It is 65 feet shorter overall because, like B-Plant, it does not include the two development cells provided in T-Plant. It was not used to separate plutonium from irradiated fuel as process improvements and other efficiency improvements in T- and B-Plants were sufficient to meet the plutonium recovery schedule. U-Plant was used as a training facility for the two other plants. By 1952, U-Plant was modified to separate, recover, and recycle uranium from the high-level T-Plant and B-Plant wastes in the underground storage tanks. As such, it was a significant element in the Hanford uranium recycle process [Gerber 1996].

2.2.3.2 Material Flowsheet

A simplified U-Plant process flow diagram for the recovery of uranium from retrieved B-Plant and T-Plant tank waste is depicted in Figure 2-4 and is based upon the use of

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tributyl phosphate (TBP). The TBP was found to complex very well with both uranium and plutonium to allow their separation from fission products and from each other after proper chemical adjustments. The process consisted basically of contacting the clarified and concentrated acidic uranium solution that had been sluiced from the waste storage tanks with TBP carried in a hydrocarbon solvent to complex the uranium with the TBP. This process was done as a one-pass counter-current solvent extraction process using packed columns. The uranium complexed with the TBP and thus transferred to an organic phase, while the fission products remained in the aqueous phase. The acidic aqueous waste from the column was neutralized and returned to the underground waste tanks for storage. The uranium was then stripped from the TBP-uranium complex in the organic phase in another packed column with acid of a specific molarity. The resultant uranium solution was then concentrated in an evaporator to a consistent concentration for feed to the UO_3 Plant. The concentrated uranium nitrate solution (uranyl nitrate hexahydrate (UNH)) was analyzed to assure that it met feed specifications for the UO_3 Plant and then transferred to that facility for conversion to shippable powder. Product solutions not meeting the stringent specification of the UO_3 Plant were recycled back through the extraction process. In order to accommodate the required throughput rate, there were two extraction trains in U-Plant.

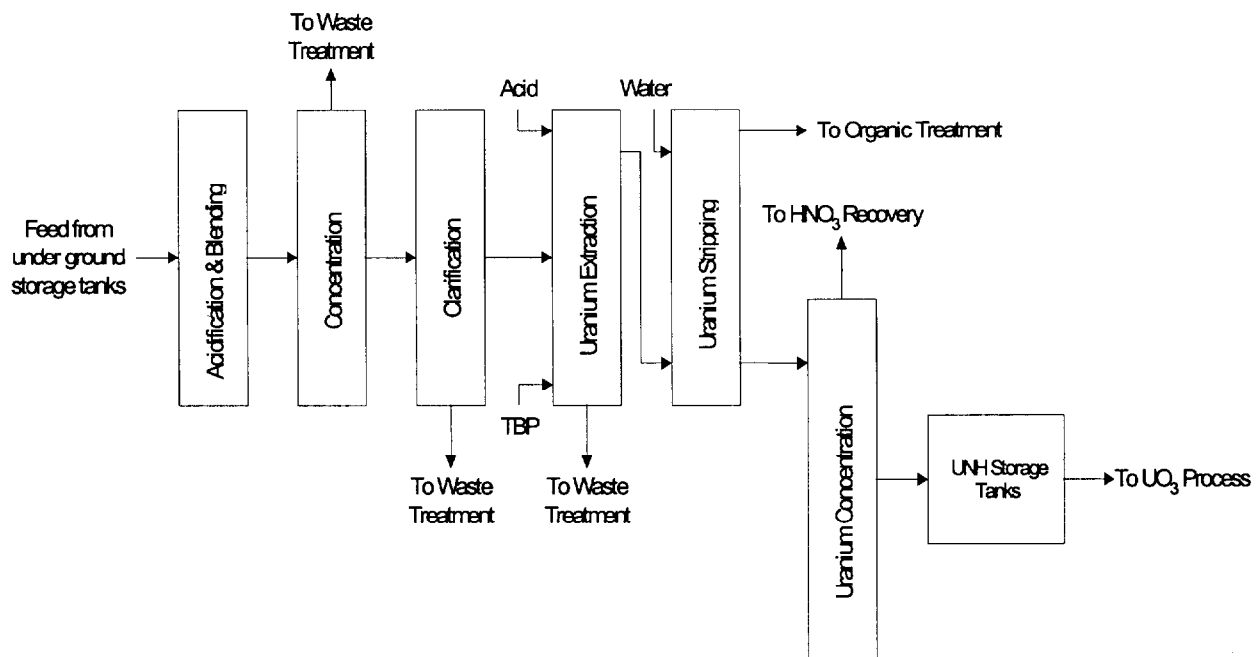


Figure 2-4 Simplified U-Plant Tributyl Phosphate (TBP) Process Flow Diagram

2.2.3.3 Feed Specifications

Feed for U-Plant came from the underground storage tanks which contained high level waste from the B and T separation plants. The uranium-bearing tank wastes consisted

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of sludge and supernatant liquor (sludge washings and solutions). The sludge contained approximately 75 percent of the uranium. The plutonium content of the uranium waste was about two to four grams per metric ton (MT) of uranium (2-4 ppm Pu). Approximately 20 MT of slurried tank waste was required to produce one ton of recovered uranium for conversion to UO_3 . A description of the chemical constituents of the "mined" uranium feed can be found in the Uranium Recovery Technical Manual [HW-19140 1951].

2.2.3.4 Product Specifications

The U-Plant product specifications were dictated by the specifications for the UO_3 powder produced in the UO_3 Plant. The initial specification in the 1951 technical manual [HW-19140 1951] indicated the UNH product from U-Plant should contain less than 80 ppb Pu. The UO_3 Plant did not further refine the UNH product from the U-Plant process. Blending of the U-Plant product with product from REDOX was expected to help assure the concentration of transuranics and fission product impurities were at acceptable levels. U-Plant did have the capability to concentrate the UNH prior to calcination, however this did not alter the ratio of any impurities to uranium.

2.2.3.5 Operating History

Uranium was scarce in the late 1940s. Escalating demand for weapons materials led to the decision to reclaim uranium from the underground storage tanks. This was first discussed in 1947 when a decision was made to develop a process for extracting uranium from the Hanford waste tanks to supplement the scarce uranium supplies [Peterson 1947]. Over the next few years, a uranium recovery process based upon TPB was developed at Hanford and served as the design basis for both the U-Plant conversion and the PUREX separations operations. U-Plant began recovering uranium from tank wastes in 1952 and completed its mission in 1958. UNH product from U-Plant was routinely blended with UNH product from REDOX. During U-Plant's operating period, ~7,200 MTU was recovered from high-level waste for conversion to UO_3 and recycle.

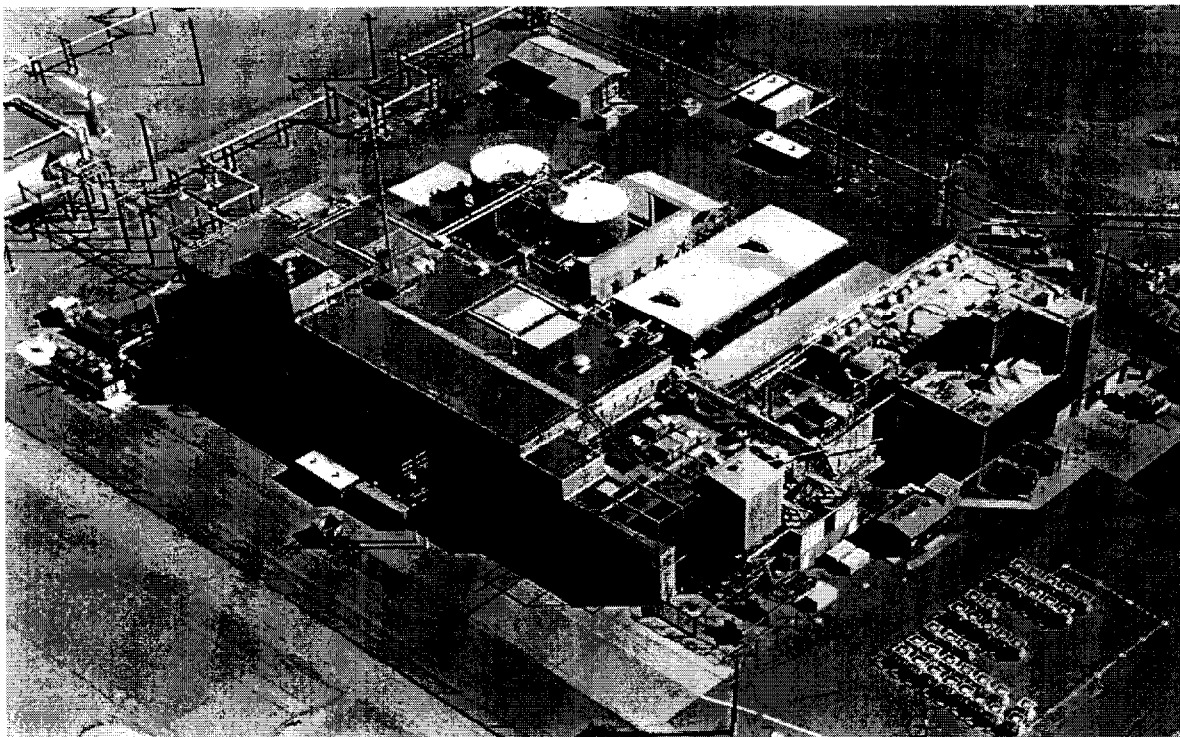
Worker exposure to uranium was normally low, as processing occurred remotely in heavily shielded and ventilated canyon cells. The uranium solutions were of low concentration until the solution was evaporated to create the UNH product. Transfer of concentrated UNH to the UO_3 plant was by pipeline. Liquid wastes containing fission products and plutonium were transferred to underground waste storage tanks. Solid wastes were packaged and sent to the Hanford burial sites for disposal.

2.2.3.6 Current Status

U-Plant is presently undergoing decontamination and decommissioning. It's final state is the subject of an ongoing Canyon Disposition Initiative at Hanford.

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2.2.4 UO₃ Plant

The UO₃ Plant was built to convert UNH solution into shippable uranium trioxide (UO₃) powder.

2.2.4.1 Plant Description

The results of process improvements in the T-Plant and B-Plant operations as early as 1945 demonstrated that U-Plant was not needed to process irradiated fuel. The 224-U Building at the U-Plant complex was subsequently modified to convert UNH into UO₃, hence its designation as the UO₃ Plant. The 224-U Building was a three-story, frame and concrete block structure which had just under 12,000 square feet, and had been constructed to house a part of the plutonium separation and concentration process used at Hanford in the 1940s. Conversion of the 224-U Building into the UO₃ Plant was completed in 1951.

The basic UO₃ process consisted of concentrating and then heating liquid UNH until it was calcined into a stable, orange-yellow UO₃ powder. At the same time, nitric acid was recovered for reuse. It was not possible to operate the UO₃ process at Hanford until a feed supply of UNH became available in 1952 with the startup of the REDOX Plant and then, within a few months, the U-Plant. The earlier separation processes used at B-Plant and T-Plant were unable to recover the uranium for recycle. However, the newer solvent extraction processes used at REDOX and U-Plant allowed recovery of uranium as a concentrated UNH.

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2.2.4.2 Material Flowsheet

The initial UO_3 process operations utilized a batch calcination process involving 18 stirred kettles, as shown in Figure 2-5. The concentrated UNH was initially heated in the stirred kettles until it was dry and then further heated until the UNH decomposed into UO_3 . The nitric acid resulting from the drying and calcining processes was recovered and concentrated. The concentrated nitric acid was returned to the separation plants for reuse. The UO_3 powder was removed from the kettles and pneumatically transferred into storage bins. The air used to transport the UO_3 was filtered before discharge to the atmosphere. The condensate stream was sampled to verify compliance with existing regulations and discharged to the cribs. The UO_3

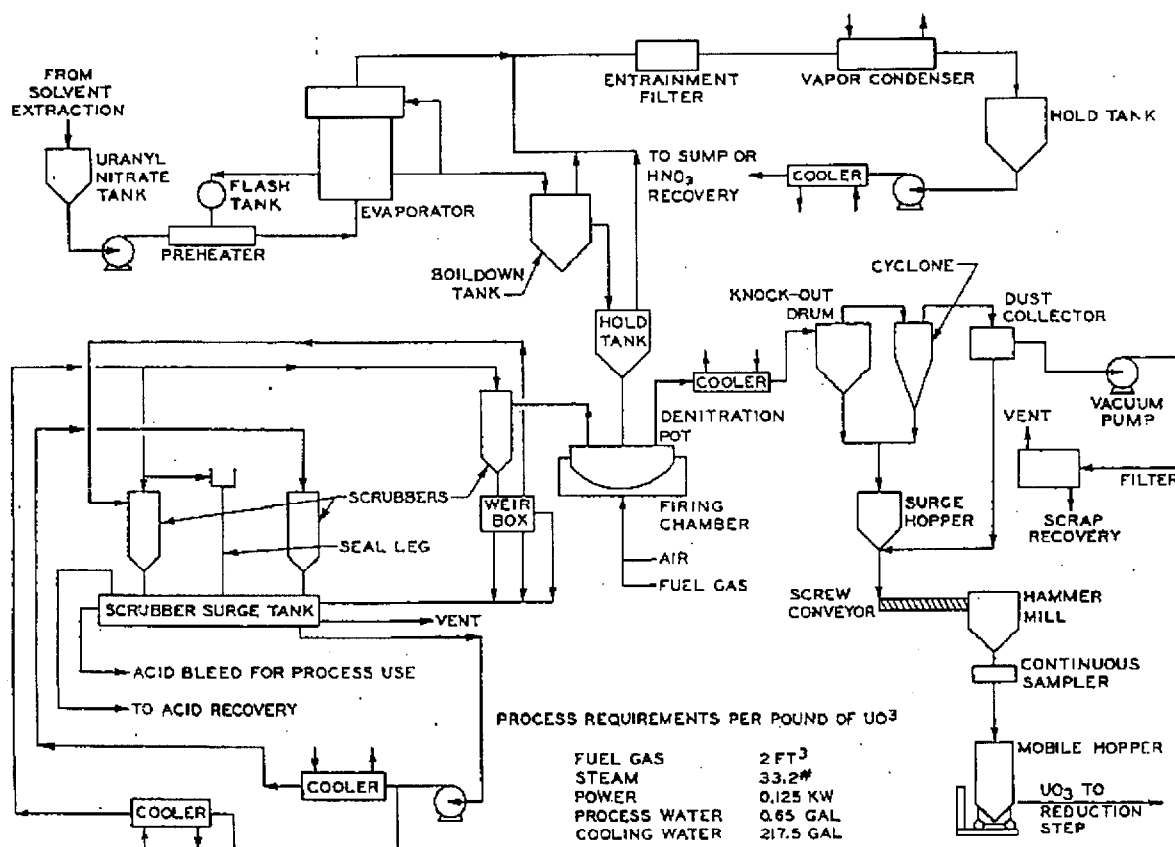


Figure 2-5 UO_3 Plant Process Diagram Involving Batch Pot Calciners

product was sampled and tested to assure compliance with product specifications. At times, the powder was ground to a specific particle size to meet chemical reactivity specifications. Sulfuric acid was added to the UNH to control the hydrofluorination reactivity of the UO_3 powder at the gaseous diffusion plants. Off-specification UO_3

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powder was either blended with acceptable UO_3 product to bring the impurities to within specification requirements, or waivers were obtained before shipment.

In 1956, the 18 kettle calciners were replaced with 6 stirred continuous calciners as shown in Figure 2-6 to improve the product quality and increase the production rate. In addition, an evaporator further concentrated the UNH feed solution from the separation plants to allow more effective calcination. The concentrated UNH was sprayed on a heated UO_3 powder bed in the continuous calciners. The UNH quickly dried, decomposed and was calcined to UO_3 powder. The UO_3 product overflowed the calciner and was pneumatically transferred to the holding bins pending acceptance testing and subsequent packaging into T-hoppers or drums. Nitric acid driven off in the calcination process was recovered and returned to the separation plants for reuse.

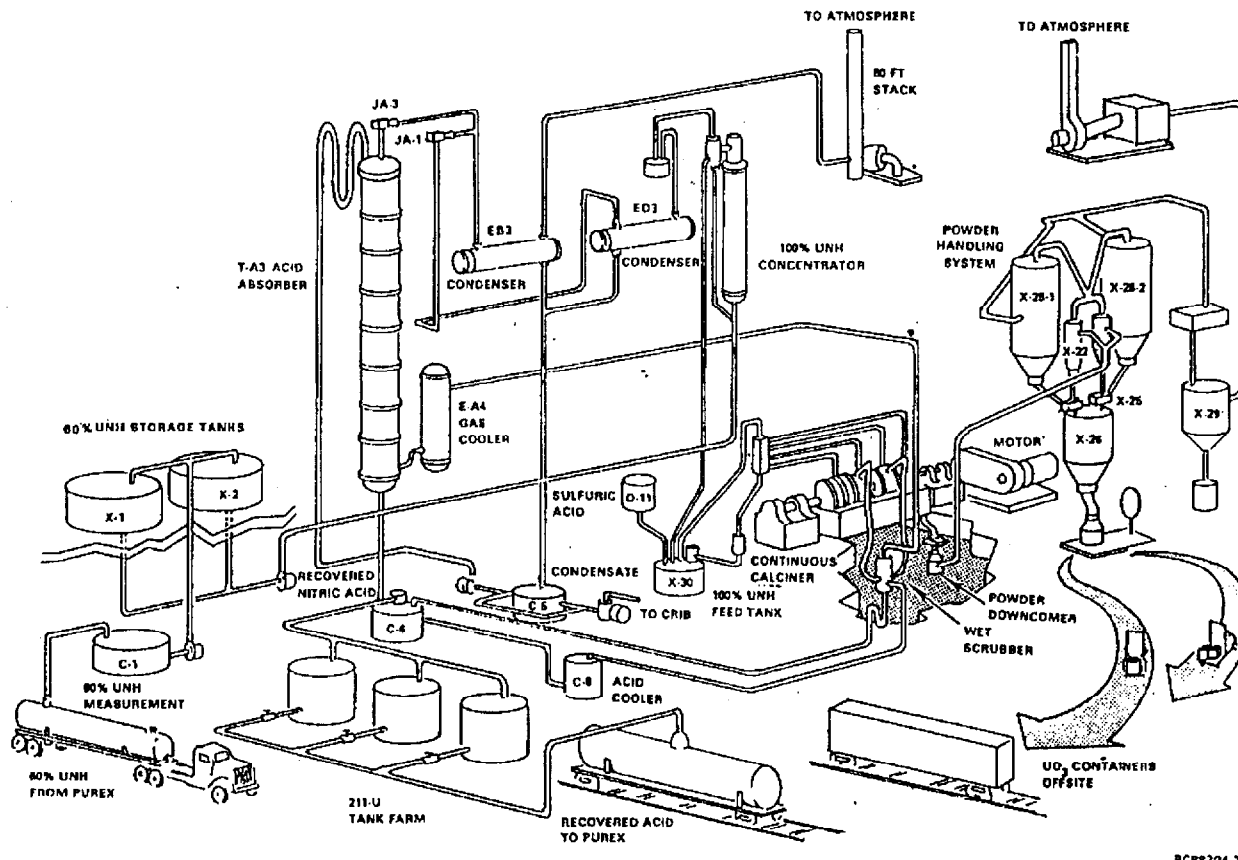


Figure 2-6 UO_3 Plant Process Diagram Involving Continuous Calciners

During the time when UO_3 Plant operated with continuous calciners, the product loadout system was configured approximately as shown in Figure 2-7. Powder in the pickup bin was fluidized and transported to cyclone separators on the fourth floor of the 224-UA tower. The heavy powder dropped out of the cyclone into the storage hopper. The remaining air and powder fines were filtered on primary bag filters, secondary filter

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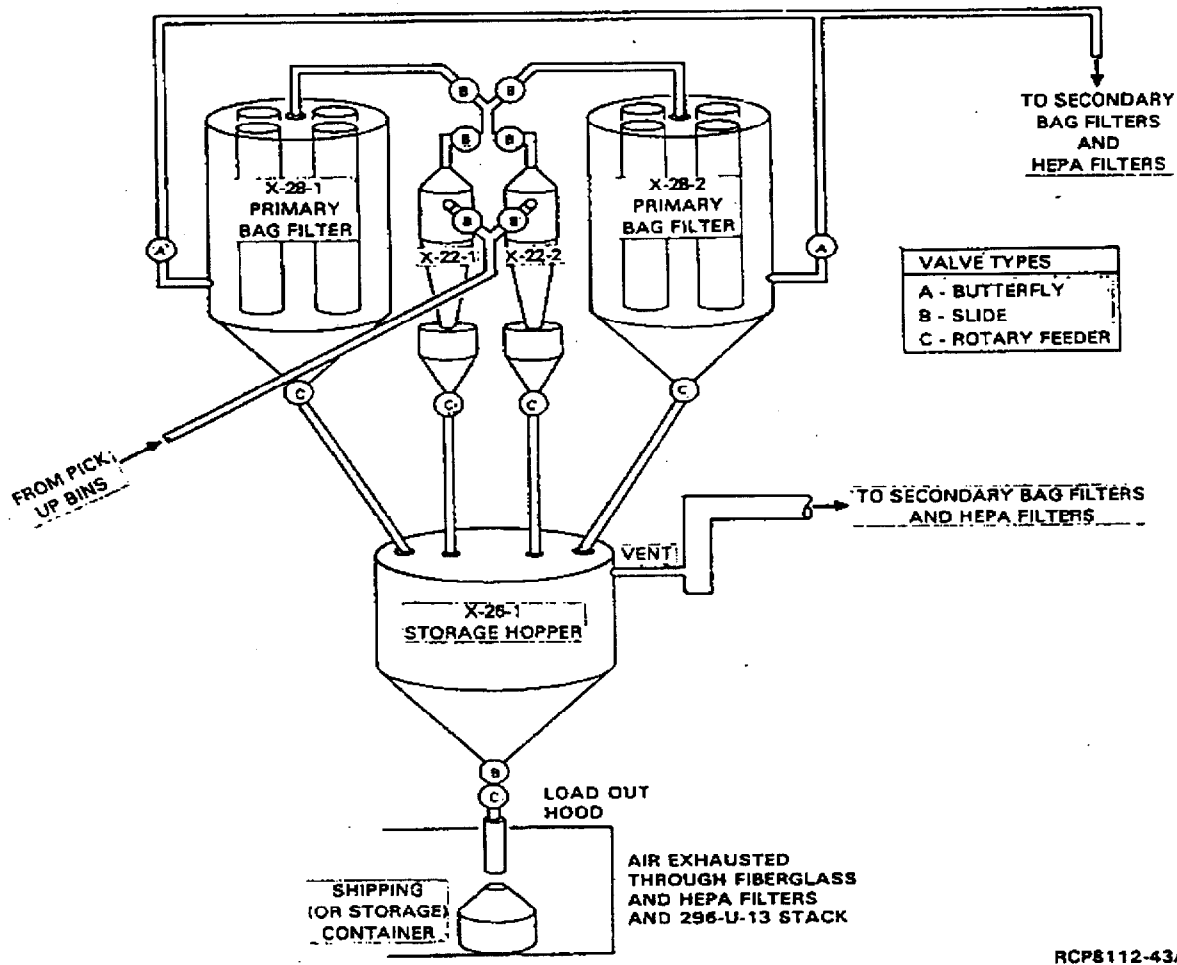


Figure 2-7 UO₃ Product Loadout System

bags, and then on high efficiency particulate air (HEPA) filters, which were added during the 1972 to 1984 shutdown time period. The powder was sampled for acceptance testing [Gustavson 1950].

Acceptable powder in the storage hopper was loaded into approved containers in the 224-UA loadout room. A forklift transported these containers to the 2714-U storage area. From this area, the UO₃ powder was shipped offsite by railcar or truck.

Of all Hanford uranium recycle activities, operation of the UO₃ Plant presented one of the greatest potentials for worker inhalation exposure to uranium and its contaminants because the product was a powder. In this facility, liquid uranium solutions were converted into dry UO₃ powder in ventilated batch kettles or continuous calciners. The calciners were ventilated to recover the nitric acid produced during calcination for reuse. The dry powder was handled pneumatically to minimize worker exposure. Packaging of the UO₃ into drums and T-Hoppers and maintenance on calciners and off-gas filters

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offered the highest potential for exposure to airborne powder. The transfer operation was performed within a ventilated enclosure to assist in dust control.

More detailed information on the UO_3 Plant is provided in Appendix G.

2.2.4.3 Feed Specifications

Feed specifications for the initial operation of the UO_3 Plant are provided in the "Uranium Recovery Technical Manual" [HW-19140 1951]. This specification indicates that the product material from REDOX and U-Plant was tightly controlled, as the UO_3 process provided no further purification of the uranium. The need for process control was recognized in the late 1940s and early 1950s before the plant came on line. The need to maintain the plutonium contamination to very low concentrations was recognized and included in the technical manual. Decisions were made in the late 1940s [Peterson 1947] to enrich the depleted uranium back to normal concentrations. Discussions followed regarding "firm specifications" for the final uranium product to be delivered [Greninger 1950].

The separation plants were originally designed on the basis that the recovered uranium would be sufficiently decontaminated with respect to Pu and gross beta and gamma radiation to permit essentially direct physical handling of the final product in its last form at Hanford. It was also recognized at this early stage that subsequent processing at other plants might result in fractionation or concentration of either fission products or of plutonium and cause a need for more highly specific or greater decontamination than would be required at Hanford. In a 1951 letter [Gamertsfelder 1951], it is stated that "...reclaimed uranium should contain no more than one part plutonium in 7.8×10^6 parts uranium." in order that the hazard due to breathing air contaminated with reclaimed uranium should be no more than 10% greater than for ordinary uranium.

2.2.4.4 Product Specifications:

A "tentative" UO_3 product specification was initially defined in the "REDOX Technical Manual" [HW-18700 1951]. This tentative specification established the following constituent limits:

- | | |
|--|---|
| • Beta Activity from Fission Products | Not more than 30% of beta activity of natural uranium |
| • Gamma Activity from Fission Products | Not more than 300% of gamma activity of natural uranium |
| • UO_3 Purity | 97% minimum |
| • Plutonium | 100 parts per billion parts of uranium |

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Negotiations continued on UO_3 specifications in 1952, when preliminary specifications were considered which indicated a desired maximum plutonium concentration of 10 ppbp uranium [Hurd 1952]. In 1953, based on operating experience, representatives from Hanford and Oak Ridge agreed upon the properties of the Hanford UO_3 to be included in a firm specification [Smith 1953]. These properties included fission product activity, plutonium content, purity (UO_3 content), particle size, and volatile impurity content, and specified that "The maximum acceptable plutonium concentration shall be ten parts of plutonium per billion parts of uranium. Plutonium shall be determined on each carload composite." The 1953 revised specification is given in [Smith 1953]. The new constituent levels were established as follows:

Firm Specifications Properties:

- Gamma Activity - the average gamma activity for any ten consecutive carload shipments shall be 100% the gamma activity of aged natural uranium. Defined as follows: for the purpose of establishing the average acceptable gamma activity specification, shipments of uranium oxide to K-25 will be considered in designated blocks of ten consecutive carloads. The average acceptable gamma activity due to fission products for a block shall be 100% the gamma activity of aged natural uranium. For the purpose of establishing the maximum gamma activity specification, one carload of oxide shall be considered a unit. The maximum acceptable gamma activity, due to fission products, for a unit shall be 300% the gamma activity of aged natural uranium.
- Beta Activity - the maximum acceptable beta activity, due to fission products, shall be 100% the beta activity of aged natural uranium. Beta activity shall be determined on each carload composite.
- Plutonium Content - the maximum acceptable plutonium concentration shall be ten parts of plutonium per billion parts of uranium. Plutonium shall be determined on each carload composite.
- UO_3 Content - the minimum acceptable UO_3 content shall be 97%. The UO_3 content shall be determined on each lot of 8 drums.

During the operating history of UO_3 production, numerous changes were made to the product specification to better control specific isotopes contributing to beta-gamma exposure of workers. Figure 2-6 shows a copy from one of the early Hanford UO_3 product specifications, indicating an allowed maximum plutonium concentration of 10 ppbp uranium [Smith 1959]. A more complete discussion on specification development and compliance is provided in Section 4.

Product specifications were also discussed, but not adopted, for ^{233}U , ^{232}U , ^{237}Np , and ^{99}Tc . In 1962 [Judson 1962] it was proposed that the maximum concentration of ^{233}U be set at 90 ppm on a ^{235}U basis, and that ^{232}U be set at 110×10^{-4} ppm on a ^{235}U

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		HW-59136
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	<u>Analysis</u>	<u>Method Ref.</u>
		<u>HW-24403</u>
	Sodium	1000.1, 769
	Calcium	1000.1
	Aluminum	1000.1
	Iron	1000.1, 515.25
	Chromium	1000.1, 341.1
	Nickel	1000.1
	Density, bulk	847.2
	Density, packed	847.5
3.22 <u>Properties with Established Limits</u>		
3.22.1 <u>Gamma Activity</u>		
Gamma activity due to fission products shall be determined on each carload composite. For the purpose of setting the average acceptable gamma activity, shipments of uranium oxide will be considered in designated blocks of ten consecutive carloads. The average acceptable gamma activity due to fission products for a block shall not exceed 100 percent of the gamma activity for aged normal uranium. For the purpose of setting the maximum acceptable gamma activity specification, one carload shall be considered a unit. The maximum acceptable gamma activity for a unit, due to fission products, shall be 300 percent of the gamma activity of aged normal uranium.		
3.22.2 <u>Beta Activity</u>		
Beta activity due to fission products shall be determined on each carload composite. The maximum acceptable beta activity due to fission products shall be 100 percent of the beta activity of aged normal uranium.		
3.22.3 <u>Plutonium Content</u>		
Plutonium shall be determined on each carload composite. The maximum acceptable plutonium concentration shall be ten parts of plutonium per billion parts of uranium.		

Figure 2-8 Copy Of Early UO₃ Product Specification

basis. In 1971, it was recommended a Np specification of <1 ppm for a lot composite and <0.3 ppm on 10 lot composites [Elgert 1971]. And in 1982 a ⁹⁹Tc specification of 0.4 ppm was proposed [Miskho 1982]. At that time it was implied that there was a 400 ppm limit for ⁹⁹Tc, but it has never been part of the Hanford specifications for UO₃ product.

2.2.4.5 Operating History

The facility began test runs in January 1952, and was in full operation the following month. Thus, for the first time, a full cycle of uranium into and out of Hanford was completed. The first UO₃ calciners simply were large pots that heated the UNH in batches. During the initial operation of U-Plant, the UNH product resulted in UO₃ product which required additional purification to remove non-radioactive impurities. This material was shipped off-site for purification. By the end of 1953, however, process improvements in both the REDOX Plant and U-Plant resulted in UNH so pure that the UO₃ Plant product no longer had to be sent offsite for further purification. This UO₃ was able to be shipped and used directly at Oak Ridge.

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HANFORD SITE HISTORICAL OVERVIEW

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During 1954, UO_3 Plant capacity increased to 18 tons per day with the addition of two gas-fired calciners. Overall production in 1954 was limited, however, by the quantity of feed available from the REDOX and U-Plants. A key improvement that year was the use of vacuum cleaning techniques that enabled the plant to recover 90-95 percent of the oxide powder associated with failed filter bags.

During 1955, monthly UO_3 production averaged 106 percent that of 1954, while the unit costs per ton dropped to 92 percent those of the previous year. In 1956, equipment modifications, including new pot agitators, shafts, seals, bearings and supports, as well as new pot cover assemblies, off-gas systems, and gasketing were employed.

In the same time frame, plans went forward to construct the 224-UA Building, a major addition to the UO_3 Plant, with six large, new, continuous action calciners. These calciners were developed and designed at Hanford. They had large troughs with paddle agitators that turned and mixed the UNH/ UO_3 bed throughout the process. The caking and clogging problems that had plagued the pots were obviated by the below-grade valving of the continuous calciners. The new valves used air to agitate the powder, and provided a seal between the calciner and the powder pickup bin, while passing a continuous stream of UO_3 .

The new calciners also produced a pebbly product that consisted of spheres with an average diameter of 200 microns (about 1/100th of an inch), as opposed to the granular oxide product of the pots. The first three continuous calciners began operation in the last quarter of 1956 at the same time specially designed T-Hoppers began to replace the 900 pound drums as shipping containers. The T-Hoppers left the site on specially fitted rail flat cars and served as feed hoppers for the Oak Ridge plant customer.

Installation of the last three of the continuous calciners was completed in early 1957. At that time, the 18 pot units were retired from service, and all processing was done through the continuous calciners. Late that year, design was initiated for new facilities which were needed to segregate regular UNH feed from that generated by the processing of enriched metal (E-Metal) in the REDOX Plant. The UO_3 powder that resulted from processing the two types of UNH streams had significantly different nuclear reactivity levels. It was necessary to maintain separation of these streams for the customer at Oak Ridge. Routine transfers of enriched UO_3 from Hanford to Oak Ridge began in early 1959.

In 1958, U-Plant finished its uranium recovery mission and was shut down. However, the quantity of PUREX Plant UNH product being shipped to the UO_3 Plant far surpassed that which had come from U-Plant. Together, the UO_3 and PUREX Plants went on to set and surpass production records almost continually, while the REDOX Plant continued to supply a small stream of enriched UNH until its shutdown in 1967.

During 1959, the concentration equipment and the acid recovery system at the UO_3 Plant were automated. In 1960, the calciners were also automated so that they could be operated and shut down remotely. In 1963, production of UO_3 shipped offsite rose to

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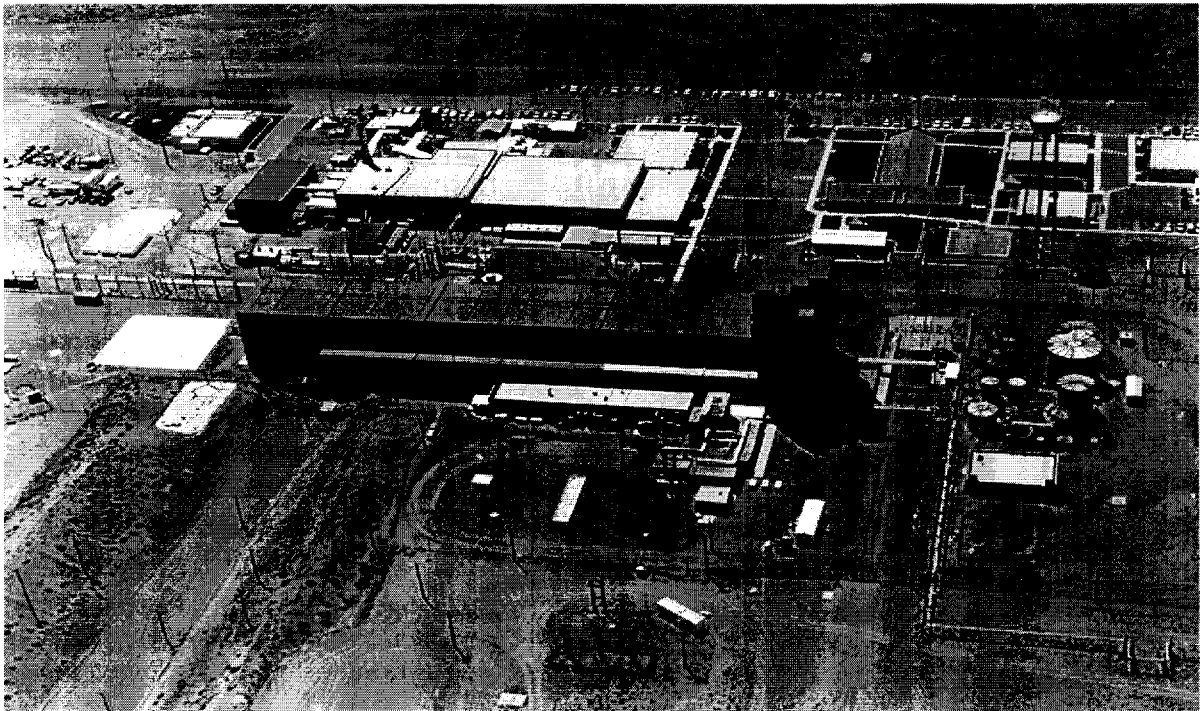
about 12,000 tons per year, and capability was added for processing UNH derived from processing metal enriched to 1.25% ^{235}U (125 Metal).

Beginning in 1967, UO_3 Plant operations were tied exclusively to those of the PUREX Plant. That year, UNH concentrator modifications in the UO_3 Plant improved heat distribution and allowed the calciner feed to maintain a uniformly higher specific gravity, thus producing more powder in the same operating time. Both the UO_3 and PUREX plants closed in 1972, and PUREX resumed operations in late 1983 -- closely followed by UO_3 in early 1984 [Gerber 1996].

In the 1980s, approximately 2-3 campaigns were processed per year. A typical processing campaign was ~22 days at a rate of 34 MTU/day (70% of instantaneous rate). This process rate was based upon all 6 continuous calciners being used. Campaigns would range from 21-32 days.

2.2.4.6 Current Status

The UO_3 Plant has been deactivated and is awaiting decontamination and decommissioning.



2.2.5 REDOX Plant

The REDOX separation plant was the second generation process facility designed to extract plutonium from irradiated uranium fuel. It recovered uranium as a co-product. It